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CERTIFICATE

This certificate is issued in support of an application for Patent registration in a country outside New Zealand pursuant to the Patents Act 1953 and the Regulations thereunder.

I hereby certify that annexed is a true copy of the Provisional Specification as filed on 31 July 2003 with an application for Letters Patent number 527318 made by Gary Christopher, Kathleen Gail Christopher and David Malcom Vince Gibbs as Trustees of the CHRISTOPHER FAMILY TRUST.

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Dated 31 August 2004.

Neville Harris

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Commissioner of Patents, Trade Marks and Designs

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PATENTS ACT 1953
PROVISIONAL SPECIFICATION

SEPARATION APPARATUS AND METHOD

WE Gary CHRISTOPHER of 58 Roberta Avenue, Glendowie, Auckland 1005, New Zealand, Kathleen Gail CHRISTOPHER of 58 Roberta Avenue, Glendowie, Auckland 1005, New Zealand, and David Malcom Vince GIBBS of 76D Avimore Drive, Highland Park, Auckland 1705, New Zealand all New Zealand citizens as Trustees of the CHRISTOPHER FAMILY TRUST

do hereby declare this invention to be described in the following statement:

SEPARATION APPARATUS AND METHOD

TECHNICAL FIELD

This invention relations to separation apparatus and method, in particular, though not solely, to an apparatus and process for separating contaminants from a liquid.

BACKGROUND ART

Separation of materials from liquids is a relatively well explored and developed technical field in which improvements are continually being made.

Treatment systems for are a constant source of research and development in order attempt to refine the processes used to treat such liquids, and at this time simple and generally cost effective treatment or pre-treatment operations are preferred.

Treatment of liquids such as storm water run-off from road networks, airport runways, industrial manufacturing operations which may have entrained hydrocarbons (in particular petroleum hydrocarbons used within the transport industries), insoluble solids and heavy metals, is often required in order to meet the environmental discharge conditions imposed upon such operations, and/or to alleviate the loading on municipal treatment works and/or to minimise environmental impact by discharge of raw effluent.

In order to remove insoluble materials from liquids, such as grit and heavy metals, gravity-type separators have been often utilised. These separators are based on the principal of movement of particles relative to the fluid, where the force exerted on the particles which induces movement is gravity

and where the particles are heavier than the suspending liquid. This is essentially a settling operation in which it is necessary that the liquid velocity is kept as low as possible in order to allow the particles sufficient residence time within the vessel (tank or chamber) to settle. The particles which settle are usually removed from the floor of the tank by scrapers (or similar means).

A number of the above described settling chambers may be used in series to maximise the particles removed from the liquid, however this may not remove all particulate matter, especially where the remaining particles are relatively small (fines), and where large flow volumes are being treated.

The remaining unsettled particles (these may be fine particles) in the liquid may then be treated for removal by methods such as precipitation, agglomeration by the addition of flocculating agents, mechanical filtration such as cake filters (utilising filter aids) and/or other mechanical pressure type filtration means, and other similar known particulate removal methods.

Traditionally, filters (in particular screen-type filters) have been designed which generally include some porous media in which preferably the resistance to flow is constant (although in practice, almost always after a period of filtration there is a resultant increase in the pressure drop across the filter); assuming constant liquid flow and pressure. Further, in general the porous but resisting media prevents materials of particular size from passing through to the downstream liquid flow side of the filter. Effectively, such filters provide in essence a grid of pre-determined gaps, though which particles of a smaller size may pass, whilst those particles of a greater size do not.

Separation of components from liquids by electrostatic attraction has also

been used; however this may have disadvantages in that the system requires a more complex arrangement and chamber configuration in order to contain the separated components.

It is an object of the present invention to provide separation apparatus and/or a method of liquid treatment which will go at least some way towards addressing the above disadvantages, and/or to provide the industry with a useful choice.

It may be advantageous to control the size and type of materials removed from a contaminated liquid feed at each stage of a multi-stage separation process and improvements to the overall system for separation performance, and types of materials able to be separated in addition to the relative control of separation would be desirable. It may also be advantageous to combine a number of separation operations for enhanced separation capabilities.

All references, including any patents or patent applications cited in this specification are hereby incorporated by reference. No admission is made that any reference constitutes prior art. The discussion of the references states what their authors assert, and the applicants reserve the right to challenge the accuracy and pertinency of the cited documents. It will be clearly understood that, although a number of prior art publications are referred to herein, this reference does not constitute an admission that any of these documents form part of the common general knowledge in the art, in New Zealand or in any other country.

It is acknowledged that the term 'comprise' may, under varying jurisdictions, be attributed with either an exclusive or an inclusive meaning. For the purpose of this specification, and unless otherwise noted, the term

'comprise' shall have an inclusive meaning - i.e. that it will be taken to mean an inclusion of not only the listed components it directly references, but also other non-specified components or elements. This rationale will also be used when the term 'comprised' or 'comprising' is used in relation to one or more steps in a method or process.

Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

DISCLOSURE OF INVENTION

Apparatus for separation of contaminants from a liquid comprising;

gravitational separation means, and

screen filter means receiving output from said gravitation separation means,

wherein said screen filter includes woollen fibre.

Preferably, the gravitational separation means includes at least one woollen fibre filter stage.

Preferably, the screen filter or filter of the gravitational separation means, comprises a composite of one or more of the following components:

i) woollen fibre,
ii) polypropylene fibre,
iii) polyester fibre

or other synthetic fibre.

Preferably, the composite components of (i), (ii) and (iii) are in the ratio of 80:10:10 on a dry weight basis.

Preferably, a plurality of screen filters progressively denser in the direction of flow of the liquid, and the fibres of the screen filters may be carded and/or twisted and/or warped and/or knitted and/or felted.

Preferably, the apparatus is configured to provide a circular flow path for the liquid.

Preferably, a series of connected concentric circular chambers are provided which house. The gravitational separation means and/or the screen filter means.

Preferably, said screen filter means are provided in a screen filter means chamber which is concentric with a gravitational separation means chamber in which said gravitational separation means are provided. Preferably, the direction of flow in the screen filter means chamber is opposite to the direction of flow in the gravitational separation means chamber.

Preferably, a plurality of gravitational separation means are provided, each of which are provided in respective gravitational separation means chambers, adjacent ones of which are connected by a conduit extending from substantially at the liquid surface of a first chamber to substantially at the floor of the adjacent downstream chamber, and wherein a most upstream gravitational separation means chamber is provided with an inlet port.

Preferably, the screen filter means are provided in the form of at least one screen filter means chambers including at least one screen filter of said at least one screen filter means chambers adapted to receive the output from a gravitational separation means chamber.

In a further aspect, the invention may broadly be said to connect in apparatus for separation of contaminants from liquids comprising:

at least two connected primary chambers which operate as gravitational separators, wherein a first chamber has an inlet port and a connecting conduit to a second chamber, and

at least two connected secondary chambers each separated by a screen filter comprising a composite filter material, wherein a first of said secondary chambers receives output from the most downstream chamber and the most downstream of said secondary chambers discharges treated liquid.

In still a further aspect, the invention may broadly be said to consist in a method of liquid treatment using a separation apparatus substantially as described in the first aspect, said method comprising the steps of:

i. transporting the liquid to be treated to the gravitational separation means and processing the liquid, and

ii. transporting the liquid from step (i) to the screen filter means for further treatment and then discharging the liquid.

BRIEF DESCRIPTION OF DRAWINGS

Further aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

Figure 1 illustrates separation apparatus in accordance with one embodiment of the present invention; and

Figure 2 is a process flow diagram of separation apparatus in accordance with an embodiment of the present invention.

BEST MODES FOR CARRYING OUT THE INVENTION

Separation apparatus configuration as shown in Figure 1 may be utilised in order to separate materials (or contaminants) from a liquid for further use and/or treatment. A process as outlined in Figure 2 may be provided as a treatment process whereby a contaminated liquid input stream 1 fed into the process may result in a liquid output stream 2 including reduced contaminant matter.

Contaminants which may be entrained within the liquid feed 1 may be materials as are often found in typical run-off from road networks, airports, industrial operations or manufacturing processes and/or from municipal or industrial catchments or similar facilities. For example, this may also include run-off or spillage from bunded or dyked areas around the bases of reactor or storage vessels.

In order to help separate these sorts of materials from a liquid, the apparatus shown in Figure 1 and/or the process as illustrated in Figure 2 and described herein below may be used.

The contaminants separated by the present invention may be hydro carbonaceous (in particular petroleum hydrocarbons), insoluble materials (particles), heavy metals, and both polar and non-polar type materials. For example, diesel, petrol, arsenic, volatile organic compounds (VOC) and semi volatile organic compounds (SVOC) and suspended solids. These may all be typically found in storm water runoff from roofs, roads and paved areas. Preferably, the system as herein described is utilised to treat such runoff, particularly able to treat large volumes of liquid.

The contaminants may be separated and either discharged at outlet 2 or sent for further processing by other methods, for example mechanical, electrical or chemical operations.

Preferably, the liquid output 2 from this system provides a useful separation process which operators can use to either help reduce the loading placed on municipal treatment works, or to help comply with discharge regulations.

A contaminated liquid 1 is collected from a catchment area, such as an airport runway system, road sewers, spillway collections and transported (perhaps by tanker or piping network) and fed to a gravitational separation means 3, preferably in the form of settling separation chamber(s) 3. In the gravity separation chamber 3 the velocity of the liquid is preferably minimised, however compared to other more traditional type gravity separators, the configuration of this chamber is improved and allows for generally reduced required residence time for particles to separate and settle.

The liquid feed to the first chamber 3 is installed preferably at a position 4 low on the chamber wall 5. Preferably, the gravitational or settling chamber is divided into a plurality of compartments or more than one gravitational or

settling chamber may be provided, adjacent ones of which are connected in series by, for example, conduits 6 which have an open end 7 to receive liquid and buoyant or floating material from substantially at or near the liquid surface in the upstream gravitational chamber, and an outlet port 8 (not shown in the second chamber 3A, but shown in the third chamber 18) within a downstream chamber, wherein the outlet port 8 is located at a substantially low point on the second chamber wall or substantially near floor level. Conduits 6 may be referred to as a 'periscope riser'. The periscope riser configuration allows for materials which float or are particularly buoyant to be transported from one chamber to the next (these materials may be agglomerated or individual particle matter). Preferably, these buoyant materials are transported from gravity chamber to gravity chamber quickly, whereas heavier materials tend to fall to the floor of the gravity chambers (these particles may form a sludge and are subsequently removed from the floor by mechanical scrapers or the like). The periscope riser may also include one or more mesh grills to deflect bulk solids back into the chamber 3.

As buoyant materials are quickly removed and transported to the next downstream gravity chamber, this allows further available retention/residence time for the non-buoyant materials in which to settle out. Depending on the mass loading of the liquid with buoyant to non-buoyant materials, and the liquid flow rate, the residence time available is also influenced (as the suspended mass of material within the liquid preferably reduces at each chamber).

This gravity separation chamber configuration may be repeated in series as shown in Figure 1 (or alternatively parallel) as many times as is necessary to provide an effective separation of non-buoyant matter from the

contaminated liquid. The type of chamber configuration may also be determined somewhat by the necessary maximum operational volume to be treated ($m^3.s^{-1}$).

The first chamber 3 may also include an overflow conduit or facility 9, able to engage and cope with liquid not being processed, for instance during maintenance operations or when inflow to the system exceeds the processing capability (this may be as a result of increased resistance to flow by the screen filters, which will soon be discussed, after a period of operation). During overflow situations, the liquid may be re-directed to a holding vessel and stored temporarily until it may be processed.

The first chamber 3 (and subsequent chambers) may also include a deflection plate or bottle (not shown) at the liquid inlet point 4 to help create a pre-determined flow path within the chamber to help reduce liquid velocity. In addition, a coalescing plate (also not shown) may also be implemented to help control the liquid flow and directs liquid toward the periscope riser to reduce the residence time necessary for gravity separation of solids from buoyant materials.

The output of the liquid treated from the gravity separation chambers 3, 3A, 18 is discharged at outlet 10 and then enters a screen filter chamber 11 for final treatment and processing prior to final discharge at outlet 2. Baffle 19 ensures that liquid entering chamber 11 is caused to flow in the direction of screen filter 12. Preferably, the screen filter or filters 12 provides adsorption and/or absorption capabilities, and may comprise or include woollen fibre. One or more screen filters 12 and series or parallel arranged chambers (11,13,14,15,16,17) may be employed to contact the liquid output 10 from the gravity separation stage 3, and may affect containment of fine particles

(or hydrocarbons etc) not already contained within the gravity separation stage, and other particles carried with the liquid in suspension or as solute.

The fibre used for the filter stages may include woollen fibre which has been treated (for example, a woollen fleece is scoured, and the natural greases are removed leaving a fibre capable of adsorption of not only greases and oils, but small molecular solids) to be carded and/or twisted and/or knitted and/or slumped and/or knoped and/or knepped or woven to help enhance the potential liquid to fibre surface contact. The fibres may be a scaly material, and each strand of fibre may be coated with hooks or scales or similar particle grabbing means to help contain contaminants within the filter fibres. A desirable operation of the fibres may be that in particular hydro carbons (especially petroleum hydrocarbons) are contained within the filter fibre. The fibre filters also may include polypropylene and/or polyester micro-fibre or other scaly material or woolly type fibre materials. Polypropylene fibres have some ability to absorb materials, whilst the polyester is mainly provided as a deflection agent to reflect and bounce materials towards woollen fibres for adsorption. The density of the screen filters may vary depending upon the flow requirements and liquid conditions, or necessary material containment by the filters from the liquid being treated. Additionally, the fibre blends and ratios of each fibre component may be adjusted from application to application as required, and may be determined by the specific contaminants being targeted for removal from the liquid. For example, a typical urban road run off fibre blend may be woollen fibre 80% : polypropylene micro fibre 10% : polyester microfibre 10% (on a dry weight basis).

For example, generally where molecular solids are of sizes greater than 120μm, the quantity of polypropylene and polyester is reduced (to less than

10% by dry weight each), and where the solids are less than 120 μm, the quantity of polypropylene and polyester is increased (to a maximum of 10% by dry weight.

Preferably the flow path of the liquid through the filters is such that the opportunities for the particles, or other contaminants, to contact the woollen fibre (or other fibre of the filter) are enhanced, which may be as a result of the convoluted flow pathway through the fibre filter. The filtered liquid may then be discharged at outlet 2 or sent for further processing, such as by mechanical, electrical or chemical methods or to other suitable treatment facilities.

Alternatively, the final gravity separation chamber 18 may include a fibre filter (not shown), which generates minimal head loss in the system, and provides an initial filtering treatment stage. Preferably, this initial filtering stage contains materials such as hydro carbonaceous matter.

The screen filter stage may preferably include and utilise more than one screen filter. Even more preferably, the screen filters may have an increasing degree of fibre density (and increased complexity of convoluted flow path for the liquid being treated). It may also be desirable that the woollen fibres are treated to be warp knit felt sleeves. The screen filters may be progressively denser than the previous upstream screen when more than one screen filter is used. Advantageously, the denser the filters become, the greater the opportunity for suspended solids or other contaminants to contact the fibre and be contained. In an alternative configuration, the screen filter stages may be configured and/or sized to allow liquid to overflow the screen filter in cases where the filters become blocked ("blind-off"). A passage over the screen may be a weir spillway to reduce

the possible recharge of material already contained in the screen filter back into the liquid. This feature may enhance the life cycle performance of the overall system.

The gravity separation chamber(s) and screen filter chamber(s) may be configured to form a circular arrangement as shown in Figure 1 with the contaminated liquid entering the chamber at 4 and flowing from gravity separation chamber to gravity separation chamber, via the periscope risers 6, contra to the flow direction of the liquid being processed in the screen filter chambers 11 as shown by arrows A-E, and F-L. It may be an advantage of the circular or concentric configuration to allow optimised space useage and/or the option of constructing the above described liquid treatment process and apparatus in a concrete or hi-density polyethylene tank (or similar) and may have advantages where available construction space is minimal. This arrangement may also benefit from a slight "centrifugal" separation component.

The apparatus and process may be configured to include recycle loops from various treatment chamber stages to allow the ability for continuous and refined liquid processing. For example, the process flow diagram as shown in Figure 2 shows some possible recycle streams available. Stream 3R is a recycle of liquid from the gravity separation chamber stage 3, and may be used where particularly heavy mass loading of liquid 1 has occurred and it provides an advantage to re-process the liquid more than once through the gravitational or settling chambers. Similarly, recycle streams $11R_1$ and $11R_2$ provide the ability to recycle output 2 from the screen filter stage 11 to be either re-processed in the screen filter chamber(s) 11 or enter the gravity separation chamber(s) 3 respectively.

Stream 3W may be material removed by scrapers (or similar means) from the gravity separation chamber(s) 3, 3A, 18, and may, for example, be sent to landfill or further treatment systems. Similarly, stream 11W may be either discharged directly to the environment, or sent for further treatment, for example, at a municipal waste treatment facility.

The apparatus may be located at pipe work outfalls and subjected to tidal flows or surcharge, and advantageously the contaminants contained within the filter fibre are not dislodged, even though liquid flow may be reversed through the system. Preferably, the blend and configuration of fibre provides secure and stable adhesion/containment of contaminants, even when subjected to reverse liquid flow.

A further advantage of the present invention is the substantially biodegradable aspect of the filter fibre. This may be particularly advantageous once the used fibre filter(s) have been removed from the system, and require disposal (for example in a landfill). The screen filter stage may also be constructed to enable wetland plants to effectively camouflage the system, and may also assist somewhat with the treatment of liquids, or to some degree help in processing liquid.

Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope thereof.

Gary CHRISTOPHER, Kathleen Gail CHRISTOPHER
and David Malcom Vince GIBBS as Trustees of the CHRISTOPHER
FAMILY TRUST
by its Attorneys
<u>**JAMES & WELLS**</u>

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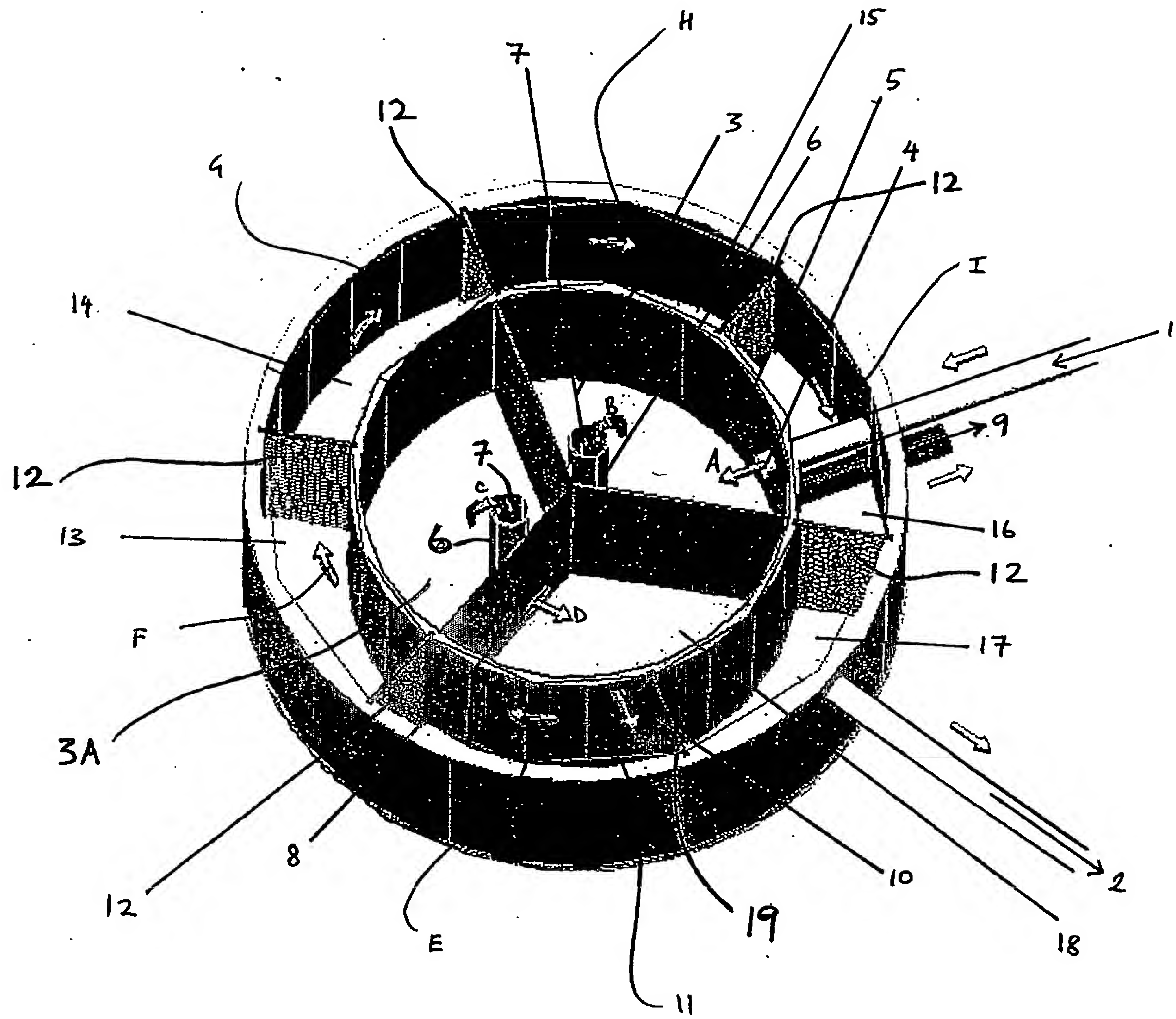

FIGURE 1

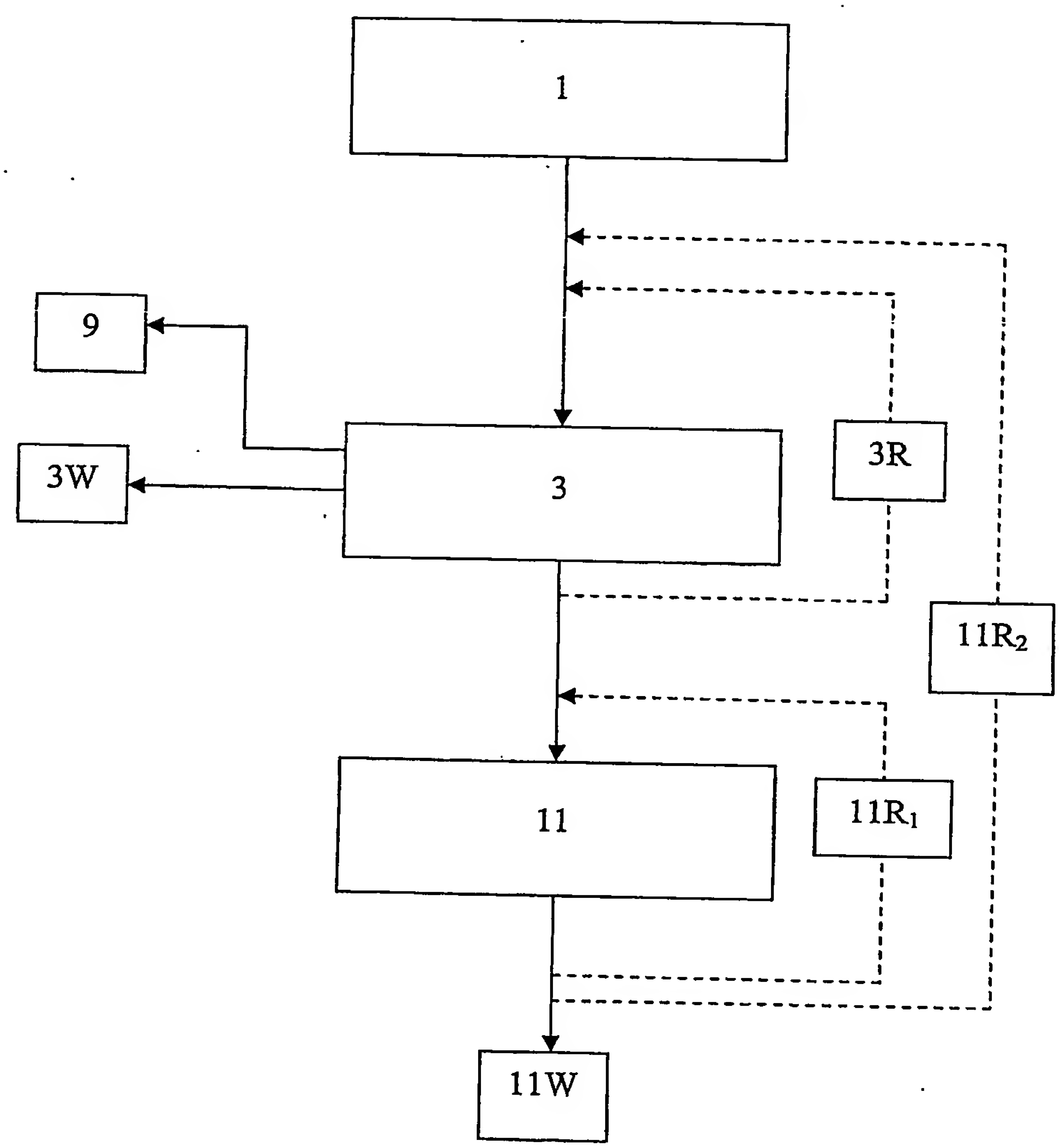

FIGURE 2